Nuclear Isomers

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A nuclear isomer is a nuclear state that is energetically above the ground state but which is typically long-lived compared to other excited states due to selection rules for nuclear transitions. Since an isomeric state and the ground state have different nuclear structure, they differ in many properties. In particular, the cross sections for neutron reactions such as (*n,n′*), (n,γ) and (*n,2n*) differ. We have studied these reactions in detail for the interesting 77 eV isomer of ^{235}U, which has a 26-minute half-life. Differences in cross sections between the ground state and the isomeric state can be significant [1].

Isomeric states are produced in the thermonuclear environment. Because of the differences in cross sections, their presence can change some aspects of the reaction kinetics (Fig. 1). It is important to understand what effect such changes will have on other physical processes. Self-consistent weapons simulations have been conducted in order to assess the effect of the isomer [2, 3]. This work is done in close collaboration with members of the Applied Physics Division (X-2 and X-4) at Los Alamos National Laboratory, and results have been presented at the 2003 Nuclear Explosives Design Physics Conference [3].

[1] J.E. Lynn and A.C. Hayes, "Theoretical Evaluations of the Fission Cross Section of the 77 eV Isomer of U235," *Phys. Rev.* C **67**, 014607 (2003).
[2] A.C. Hayes, G. Jungman, J.E. Lynn, J.C. Solem, G. Girard, S.M. Sterbenz, "The Effects of 77eV Isomer of 235U (U)," Los Alamos National Laboratory report LA-CP-04-0170 (2004).
[3] Anna C. Hayes, "Effect of 26 Minute Isomer of ^{235}U (U)," Los Alamos National Laboratory report LA-CP-04-1017 (2004).

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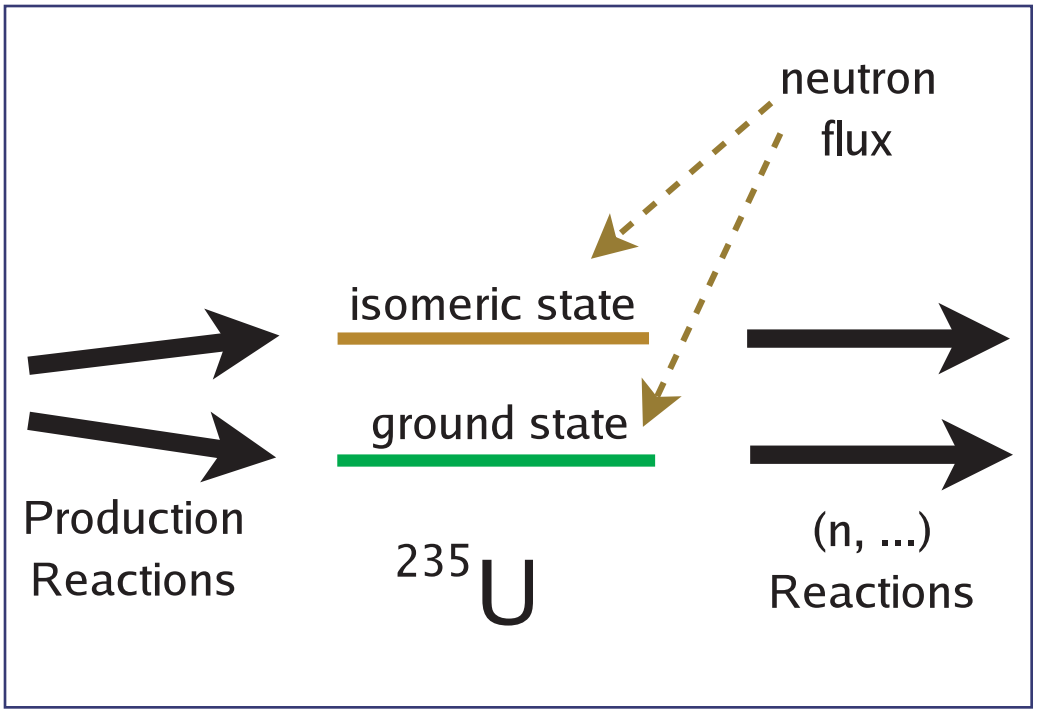

Figure 1—
In a high neutron fluence environment the isomer of ^{235}U is strongly populated. The cross sections for subsequent neutron reactions, including fission, on the isomer are different than those for the ground state. Thus, the isomer can play an important role in a nuclear explosion involving ^{235}U.